Amendment to the Drawings

Please replace the enclosed drawing Sheet 18/21 in the Application.

Remarks:

Claims 166-169, 172-174, and 177-180 are pending in the Application

Claims 166-169, 172-174, and 177-180 are rejected.

I. REJECTIONS UNDER 35 U.S.C. § 102(e) AS BEING ANTICIPATED BY FISCHER

The Examiner has rejected Claims 166, 167, 172-174, 177 and 179 under 35 U.S.C. § 102(e) as being anticipated by Fischer et al., U.S. Patent 5,985,112 ("*Fischer*"). Third Office Action, at 3. Applicant respectfully traverses the rejection.

Anticipation requires each and every element of the claim to be found within the cited prior art reference.

Examiner contends that *Fischer* discloses "a membrane of substantially parallel single-wall carbon nanotubes." Third Office Action, at 2. Examiner makes reference to Figure 3 and various citations in *Fischer*. *Id.* Examiner further contends that "[N]ot all of the nanotubes in Figure 3 are substantially parallel, however, many of the nanotubes in this figure are substantially parallel..." *Id.*

Independent claims, Claim 166, 172, 173, 177 and 179 state, respectively:

> Claim 166: A membrane comprising an array of single-wall carbon nanotubes in a substantially parallel relationship, wherein the membrane is nanoporous.
>
> Claim 172: A membrane comprising carbon fibers that are aggregates of a plurality of single-wall carbon nanotubes, wherein the plurality of single-wall carbon nanotubes are in a generally parallel orientation.
>
> Claim 173: A membrane comprising: (a) carbon fibers that are aggregates of a plurality of single-wall carbon nanotubes, wherein the plurality of single-wall carbon nanotubes are in a generally parallel orientation; and (b) at least one dopant physically entrapped between the single-wall carbon nanotubes of the carbon fibers.

> Claim 177. A battery comprising a membrane, wherein the membrane comprises an array of single-wall carbon nanotubes in a substantially parallel relationship.
>
> Claim 179. A battery comprising a membrane, wherein the membrane comprises carbon fibers that are aggregates of single-wall carbon nanotubes, and wherein the plurality of single-wall carbon nanotubes are in a generally parallel orientation.

Regarding Claims 166, 172, 173, 177 and 179, each of these claims comprise, *inter alia*, single-wall carbon nanotubes in the claimed membrane or battery, as the case may be. With all due respect to the Examiner's contentions, the straight, fibrous material, that the Examiner appears to be referring to in Figure 3 of *Fischer*, is not single-wall carbon nanotubes. Rather, the straight, fibrous material in Figure 3 is a collection of large diameter fibers, which are 4-8 μm (4000-8000 nm) in diameter. (*Fischer* at col. 2. *ll.* 60-61) These large diameter fibers "serve as a scaffolding to hold the smaller nanofibers apart and prevent the nanofiber bed from collapsing." (*Fischer* at col. 2, *ll.* 30-33.) *Fischer* also refers to these large diameter fibers as "carbon fibers." (*See, e.g., Fischer* at col. 18, *ll.* 54-55 ("The carbon fibers have a diameter of approx. 7-8 μm and the fibrils have a diameter of approx. 0.01 μm."))

Furthermore, the "web-like regions" of the micrograph of Figure 3 are also not composed of single-wall carbon nanotubes, but rather "fibril mats." (*Fischer* at col. 2, *l.* 61) The diameter of the "fibrils," given in the citation above, is approximately 0.01 μm, or 10 nanometers. (*Fischer* at col. 18, *ll.* 54-55)

Thus, the material of *Fischer* is specifically "nanofibers," which have significantly different diameters than single-wall carbon nanotubes. (*See Fischer*, col. 4, *ll.* 22-24)

The nanofibers of *Fischer*, which are also referred to as "fibrils" therein, have also been referred to as multi-wall carbon nanotubes having many walls. *Fischer* also uses the terms "carbon nanofiber," "nanotube" and "fibril," interchangeably. That the nanofibers of *Fischer* are not single-wall carbon nanotubes, is also clear from the

description of *Fischer* at col. 6, *ll.* 35-43, which states:

> Carbon nanotubes of a morphology similar to the catalytically grown fibrils described above have been grown in a high temperature carbon arc (Iijima, Nature 354 56 1991, hereby incorporated by reference). It is now generally accepted (Weaver, Science 265 1994, hereby incorporated by reference) that these arc-grown nanofibers have the same morphology as the earlier catalytically grown fibrils of Tennent. Arc grown carbon nanofibers are also useful in the invention.

Further evidence that the nanofibers of *Fischer* are not single-wall carbon nanotubes is given in the diameter of the nanofibers or fibrils. (*See, e.g., Fischer*, col. 5, *ll.* 1-15)

> U.S. Pat. No. 4,663,230 to Tennent, hereby incorporated by reference, describes carbon fibrils that are free of a continuous thermal carbon overcoat and have multiple ordered graphitic outer layers that are substantially parallel to the fibril axis.... The Tennent invention provided access to smaller diameter fibrils, typically 35 to 700 Angstroms (0.0035 to 0.070 μm)....

Note that "smaller diameter fibrils" have diameters "typically 35 to 700" Angstroms [3.5 to 70 nm]. (*Fischer* at col. 5, *ll.* 13-14.) As noted above, *Fischer* teaches that fibrils have "a diameter of approx. 0.01 μm", [10 nanometers]. (*See, e.g., Fischer* at col 18, *ll.* 54-55 ("The carbon fibers have a diameter of approx. 7-8 μm and the fibrils have a diameter of approx. 0.01 μm.")

In contrast, the diameters of single-wall carbon nanotubes are smaller than nanofibers, and generally range from about 0.7 nm to about 3 nm. (*See, e.g.,* p. 35 of M. Dresselhaus, *et al.*, (Ed) "Carbon Nanotubes, Topics Appl. Phys. **80** 29-53 (2001)), which excerpt is attached hereto at **Exhibit A.**

In contrast to the nanofibers taught by *Fischer,* Claims 166, 172, 173, 177 and 179, and those claims that depend upon them, each comprise single-wall carbon nanotubes, which are generally regarded to possess properties and handling characteristics significantly different than those of nanofibers, such as those disclosed by

Fischer.

Single-wall carbon nanotubes are unique and generally acknowledged to have been co-discovered well after the discovery of nanofibers, *i.e.*, in 1993, by Iijima and Bethune and their respective co-workers, *see* Iijima *et al.*, *Nature*, **1993**, *363*, 603 (attached hereto at **Exhibit B**), and Bethune *et al.*, *Nature*, **1993**, *363*, 605 (attached hereto at **Exhibit C**). *See also* United States Patent No. 5,424,054, issued June 13, 1995 to Bethune *et al.*

The distinction between single-wall carbon nanotubes and nanofibers is important because nanofibers are fundamentally different from single-wall carbon nanotubes. The structural differences between single wall carbon nanotubes and nanofibers cause the materials to have very different properties, as well as significant and unpredictable chemical reactivity and performance differences.

Single-wall carbon nanotubes (SWNT) have only a single layer of sp^2-hybridized carbon atoms, generally arranged in a hexagons and pentagons. SWNT are smaller in diameter than nanofibers and quite flexible. SWNT also "rope" and are held tightly together by van der Waals forces. In contrast, carbon nanofibers are composed of multiple, curved carbon layers, arranged generally in a concentric fashion. Nanofibers are much thicker and stiffer than single-wall carbon nanotubes and are quite rigid and quite inflexible. Nanofibers also do not "rope" together. The structural differences between single-wall carbon nanotubes and nanofibers result in numerous differences in physical and chemical properties, such as tensile strength, modulus, flexibility, thermal conductivity, electrical conductivity, maximum tolerable electrical current density, chemical reactivity and chemical stability.

Regarding the element of orientation of the single-wall carbon nanotubes, each of the independent claims, Claims 166, 172, 173, 177 and 179, contain the element of "substantially parallel" or "generally parallel" with regard to the single-wall carbon nanotube orientation. Examiner contends that "[N]ot all of the nanotubes in Figure 3 are

substantially parallel, however, many of the nanotubes in this figure are substantially parallel..." Third Office Action, at 2.

Figure 3 shows "...fibers (4-8 μm in diameter) and web-like regions of fibril mats." (*See Fischer* at col. 2, *ll.* 60-61) From the low magnification in the micrograph of Figure 3, it is not possible to determine the orientation of the fibrils in the mat, however, the description in Figure 2 states that the fibrils are ***randomly oriented***. (*Fischer* at col. 2, *ll.* 55-58 ("FIG. 2 is a photomicrograph (magnification of x2,000) illustrating a packed bed comprising scaffold fiber particulates and web-like structures of ***randomly oriented*** intertwined carbon fibrils.") (emphasis added))

Thus, the fibrils are not at all substantially aligned, but rather the fibrils are expressly in a "random orientation." Thus, *Fischer* does not teach or suggest alignment of fibers or fibrils, but rather seeks a random orientation of all fibers and fibrils. In fact, one of the objectives of *Fischer* is to make a random orientation of fibers. *Fischer,* at col. 2, *ll.* 6-10, states:

> It is another object of the invention to provide a composition of matter which comprises a three-dimensional, macroscopic nanofiber packed bed made up of a blend of randomly oriented nanofibers and larger scaffold particulates.

Furthermore, *Fischer,* at col. 8, *ll.* 50-53, states

> Broadly, the invention is in a composition of matter consisting essentially of a three-dimensional, macroscopic assemblage of a multiplicity of randomly oriented nanofibers, blended with scaffold particulates.

With regard to Claim 173, Examiner further contends that "[T]he scaffold particulates set forth in column 7 comprise the claimed dopant and the particulates may comprise metals." Third Office Action, at 2.

Applicant respectfully traverses the argument. First, the word "dopant" was used in an ordinary and customary meaning. According to *The Photonics Directory* on-line

dictionary, "dopant" is [an] "impurity added to a substance to produce desired properties in the substance." (An excerpt from *The Phonics Directory* on-line dictionary is attached hereto at **Exhibit D)** Second, catalyst particles are not an added impurity. Residual catalyst may be present after the nanofibers of *Fischer* are made, but are not added as an impurity to the nanofibers. Third, one of ordinary skill in the art would not consider catalyst particles a dopant, or a substance intentionally added to create the desired effect. For these reasons, Applicant contends that catalyst particles would not be considered a dopant.

In summary, *Fischer* teaches, *inter alia*, (a) nanofibers rather than single-wall carbon nanotubes, as in the present claims, and (b) random orientation of fibrils rather than "substantially aligned" or "generally aligned" single-wall carbon nanotubes, as in the present claims. Therefore, Applicant asserts that independent Claims 166, 172, 173, 177 and 179 are not anticipated by *Fischer*. Likewise, Claims 167 and 174, which are dependent upon Claims 166 and 172, respectively, would not be anticipated by *Fischer* for the same reasons that Claims 166 and 172, are not anticipated by *Fischer*.

Therefore, as a result of the foregoing, Applicant respectfully requests that the Examiner withdraw his rejection of Claims 166, 167, 172-174, 177 and 179 under 35 U.S.C. § 102(e) as being anticipated by *Fischer*.

II. REJECTIONS UNDER 35 U.S.C. § 103(a) AS BEING OBVIOUS OVER *FISCHER* IN VIEW OF *MURPHY* AND *IKEDA*

The Examiner has rejected Claims 168, 169, 178 and 180 under 35 U.S.C. § 103(a) as being unpatentable over *Fischer* in view of both Murphy *et al.*, U.S. Patent 6,448,412 ("*Murphy*") and Ikeda *et al.*, U.S. Patent 5,879,836 ("*Ikeda*"). Third Office Action, at 3. Applicant notes that it is unclear whether Examiner is rejecting these claims as obvious under 35 U.S.C. § 103(a) over (a) (i) *Fischer* in view of *Murphy* and also (ii)

Fischer in view of *Ikeda* or (b) *Fischer* in view of *Murphy* and in view of *Ikeda.* Whichever the rejections may be, Applicant traverses such rejections.

A. Rejections over *Fischer* in view of *Murphy* and over *Fischer* in view of *Ikeda*

Examiner contends that "the patent to *Fischer* sets forth all of the claimed subject matter except for the photoactive molecule attached to the membrane and for a lithium ion battery having a membrane. Murphy teaches...a fluorescent dye labeled to a fullerene." Third Office Action, at 3. Examiner contends that "[t]o thus include in the single wall carbon nanotubes of Fischer the fluorescent dye as shown by Murphy would have been obvious to one of ordinary skill in this art at the time the invention was made so that the nanotubes can be traced within the body of a diseased person." *Id.*

Applicant respectfully traverses these rejections.

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art and not based on applicant's disclosure. *See* M.P.E.P. 706.02(j); *see also In re Vaeck,* 947 F.2d 488, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991).

Independent claims, Claim 168 and 169 state, respectively:

> Claim 168. A membrane comprising: (a) an array of single-wall carbon nanotubes in a substantially parallel relationship, wherein the membrane is nanoporous; and (b) at least one photoactive molecule attached to the membrane.
>
> Claim 169: A membrane comprising an array of single-wall carbon nanotubes in a substantially parallel relationship, wherein the membrane is

nanoporous and at least one of the single-wall carbon nanotubes have ends that are derivatized with a photoactive dye molecule.

With regard to Claims 168 and 169, both of these claims require, *inter alia*, single-wall carbon nanotubes in a substantially parallel relationship. As asserted above, *Fischer* does not teach or suggest single-wall carbon nanotubes. Nor does *Fischer* teach or suggest single-wall carbon nanotubes in a "substantially parallel relationship." The arguments presented for Claims 166, 172 and 173 with respect to *Fischer*, stated above, are also applicable here.

Murphy teaches methods for multiply-derivatizing fullerenes having a C_{21-239} fullerene core. *Murphy* does not teach or suggest single-wall carbon nanotubes, nor does *Murphy* teach or suggest a membrane of single-wall carbon nanotubes in substantially parallel relationship. Regarding Claims 168 and 169, *Fischer* and *Murphy* (alone or in combination) do not teach or even suggest a membrane comprising, *inter alia*, an array of single-wall carbon nanotubes in a substantially parallel relationship. Furthermore, there is no suggestion or motivation in either *Fischer* or *Murphy* to combine the teachings of *Fischer* with the teachings of *Murphy*, and even if the teachings of *Fischer* and *Murphy* were combined, the combination would not teach or suggest all the claim limitations. Thus, Applicant asserts that Claims 168 and 169 are not *prima facie* obvious.

Regarding Claims 178 and 180, Examiner contends "*Ikeda et al.* discloses a lithium ion battery having nanotubes." Third Office Action, at 3. The Examiner further contends "[t]o have utilized the nanotubes in Fischer in the lithium battery shown by Ikeda would have been obvious so that a great output could have been realized because of the superior performance of the lithium battery." *Id.*

Applicant further respectfully traverses these rejections.

Regarding Claims 178 and 180, both of these claims are dependent upon independent Claims 177 and 179, respectively. As stated above, regarding Claims 177 and 179, both of these claims require, *inter alia*, single-wall carbon nanotubes in a

substantially parallel relationship. As asserted above, *Fischer* does not teach or suggest single-wall carbon nanotubes. Nor does *Fischer* teach or suggest single-wall carbon nanotubes in a "substantially parallel relationship" as required by Claim 177 or in a "generally parallel orientation" as required by Claim 179. The arguments presented for Claims 177 and 179 with respect to *Fischer*, stated above, are also applicable here.

Like *Fischer, Ikeda* teaches fibrils and does not teach or suggest single-wall carbon nanotubes. Nor does *Ikeda* teach or suggest a membrane of single-wall carbon nanotubes in substantially parallel relationship. Regarding Claims 177 and 179, *Fischer* and *Ikeda* do not teach or even suggest (alone or in combination) a membrane comprising, *inter alia*, an array of single-wall carbon nanotubes in a substantially parallel or a generally parallel relationship. Furthermore, there is no suggestion or motivation in either *Fischer* or *Ikeda* to combine the teachings of *Fischer* with the teachings of *Ikeda*, and even if the teachings of *Fischer* and *Ikeda* were combined, the combination would not teach or suggest all the claim limitations. Thus, Applicant asserts that Claims 177 and 179 are not *prima facie* obvious, and Claims 178 and 180, which are dependent upon Claims 177 and 179, respectively, are also not *prima facie* obvious for the same reasons Claims 177 and 179 are not *prima facie* obvious.

B. Rejections over *Fischer* in view of *Murphy* and in view of *Ikeda*

As noted above, *Fischer, Murphy,* and *Ikeda* do not teach or suggest single-wall carbon nanotubes, nor do *Fischer, Murphy,* and *Ikeda* teach or suggest a membrane of single-wall carbon nanotubes in substantially parallel relationship. For each of Claims 168, 169, 178, and 180, *Fischer, Murphy,* and *Ikeda* (alone or in combination) do not teach or even suggest a membrane comprising, *inter alia*, an array of single-wall carbon nanotubes in a substantially parallel relationship. Furthermore, there is no suggestion or motivation in any of *Fischer, Murphy,* or *Ikeda* to combine the teachings of *Fischer* with the teachings of *Murphy*, to combine the teachings of *Fischer* and *Ikeda*, to combine the teachings of *Murphy* and *Ikeda* or to combine the teachings of *Fischer, Murphy,* and *Ikeda.* And even if the teachings of *Fischer, Murphy,* and *Ikeda* were combined, the

combination would not teach or suggest all the claim limitations. Thus, Applicant asserts that Claims 168, 169, 178, and 180 are not *prima facie* obvious.

Therefore, as a result of the foregoing, Applicant respectfully requests that the Examiner withdraw his rejection of Claims 168, 169, 178 and 180 under 35 U.S.C. § 103(a) as being unpatentable over *Fischer* in view of both *Murphy* and *Ikeda.*

III. SPECIFICATION

Applicant filed the present Application on December 28, 2001 as a divisional of United States Patent Application Serial No. 09/380,545, filed on September 3, 1999 ("the Parent '545 Patent Application"). The Parent '545 Patent Application issued as United States Patent No. 6,683,783 on January 27, 2004 ("the '783 Patent").

In the Preliminary Amendment Accompanying Request For Filing Divisional Application Under 37 C.F.R. §1.53(b), filed December 28, 2001), Applicant inserted a RELATED APPLICATIONS section on page one of the Specification. Applicant has amended the first paragraph of the inserted RELATED APPLICATIONS section to reflect the issuance of the '783 Patent.

No new matter is added by this amendment to the specification.

IV. AMENDMENTS TO THE DRAWING

On December 28, 2001 (*i.e.*, the filing date of the present Application), Applicant concurrently filed United States Patent Application Serial No. 10/033,075 ("the '075 Patent Application"), which, like the present Application, is a divisional of the Parent '545 Patent Application.

In the '075 Patent Application, Applicant was requested by the USPTO to furnish a substitute drawing for FIGS. 17A and 17B appearing on Sheet 18/21 of the Application. As Applicant surmises that a similar request may be made in the present Application, to further facilitate prosecution, Applicant has herewith submitted for substitution the same substitute Sheet 18/21 that Applicant submitted and the USPTO accepted for the '075

Patent Application. Applicant has attached this substitute Sheet 18/21 herewith at **Exhibit E**.

No new matter is added by this amendment to the drawings.

V. CONCLUSION

As a result of the foregoing, it is asserted by Applicant that the Claims in the Application are now in a condition for allowance, and respectfully requests allowance of such Claims.

Applicant respectfully requests that the Examiner call Applicant's attorney at the below listed number if the Examiner believes that such a discussion would be helpful in resolving any remaining problems.

Respectfully submitted,

WINSTEAD SECHREST & MINICK P.C.
Attorneys for Applicant

By: _____
Ross Spencer Garsson
Reg. No. 38,150

Date: June 9, 2005
P.O. Box 50784
Dallas, Texas 75201
(512) 370-2870

Austin_1\282438\1
11321-P012USD3 6/9/2005